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for Strategic Studies

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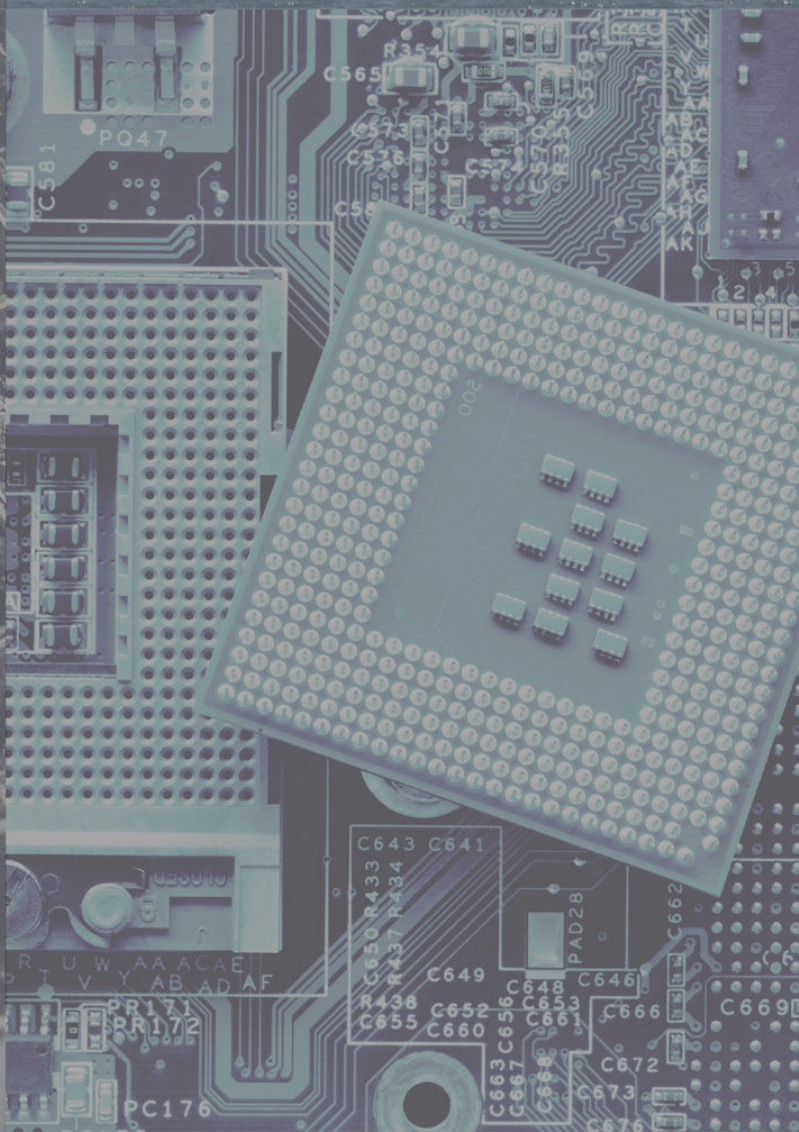
October 2023



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This paper is part of the HCSS Europe in the Indo-Pacific Hub.

November 2023

The research for and production of this report was made possible by a financial contribution from the Taipei Representative Office in the Netherlands to the Hague Centre for Strategic Studies. The conclusions and recommendations presented in this report are the result of independent research. Responsibility for the content rests with the authors and the authors alone.

Abstract

In recent years, Taiwan has produced over 60% of advanced chips (under 7nm).These advanced chips are a crucial driving engine for AI, 5G and advanced military weapons, and make the country become a geopolitical spotlight during the US-China trade and technology war. The impacts of the Chips & Science Act and technology regulation engineered by the U.S. government regarding Taiwan and its responding strategies are the focal point of this paper.

1. Foreword

The U.S.-China trade war broke out in 2018, and was originally predicted to have negative impacts on Taiwan's semiconductor industry. On the contrary, due to the high tariff rate imposed by the U.S. on China's semiconductor exports, many orders have been transferred to Taiwan, which has created a boom for Taiwan's semiconductor industry.

In order to contain China, the U.S. has introduced the Chips and Science Act to subsidise semiconductor companies from major countries to invest in the U.S. and provide tax incentives. The main purpose of the Act is to slow down China's catch-up with the U.S. by requiring semiconductor companies to choose sides. However, the U.S. was shocked when Chinese semiconductor firms claimed that they could develop 7nm chips. The next generation of 7nm are 5nm chips, which are important drivers for AI, 5G, and high-end military weapons. Ass a result, U.S. technology control on China has become increasingly stringent, which has started to impact Taiwan's semiconductor industries.

Under such circumstance, this paper aims to explore the impact of the U.S.-China technology war on Taiwan's semiconductor industry and Taiwan's role in geopolitics. In addition to the introduction, the second section analyses the importance of semiconductor industry to Taiwan's economy and the reasons for Taiwan to raise geopolitical attention; the third section examines the impact of the U.S. Chips and Science Act and technology regulation on Taiwan's semiconductors; the fourth section examines the long-term development of the U.S.-China technology war and de-China policy; and the last section proposes Taiwan's responding strategies, and some suggestions for European countries.

2. The importance of Taiwan's semiconductor industry

For a long time, the U.S. has kept IC design, intellectual property (IP), and electronic equipment automation (EDA), which have high profit margins, in the U.S., and moved foundry, packaging, and testing, which have lower added value, to Asian countries. However, facing the U.S.-China trade war and the broken chain resulting from the COVID- pandemic, companies suffered extensive damage. In addition, China's Semiconductor Manufacturing Corporation (SMIC) has announced that it can develop advanced semiconductor processes below 7nm without the use of EUV equipment, making the U.S. even more alarmed. Therefore, through the Chips and Science Act, the U.S. aims, on the one hand, to increase the self-production rate of domestic semiconductor processes, and on the other hand, it will attract Asian countries to invest in the U.S. and curb the speed of developing advanced processes in mainland China. Although the U.S. now has only an 8% global share in semiconductor manufacturing, even with the passage of the Chips and Science Act, the self-production rate can only be raised to 12%, but it has successfully attracted TSMC and Samsung Electronics to invest in the U.S., while expanding Intel's local investment. Taiwan's strengths lie in foundry, IC design, packaging and testing. Especially foundry output accounts for more than 60% of the global total; high-end processes account for more than 70% of the world.

In the development of the semiconductor industry, Europe, the U.S., Japan, Korea, and Taiwan are in fact the best in their respective fields. The U.S. remains the leader in IC design, intellectual property layout (IP), integrated device manufacturing (IDM) equipment, and electronic design automation (EDA); Europe has its advantages in equipment, especially the extreme ultraviolet (EUV) equipment from ASML in the Netherlands; Japan's raw materials and equipment occupy a place in the world. Although Taiwan has strong competitiveness in the areas of foundry, IC design and packaging testing, it still relies heavily on Europe, the US and Japan for raw materials, materials, IP and EDA. At the same time, Taiwan cannot ignore the demand side; mainland China imports nearly 80% of the world's semiconductor production, which represents an annual market of 150 billion U.S. dollars.

In addition, semiconductor production accounts for a significant part of Taiwan's economy, with its output contributing 20% of the manufacturing industry's employment, 34.8% of Taiwan's total exports (2021), and 70% of Taiwan's total trade surplus. The above figures show the importance of the semiconductor industry and that it is not without reason that manufacturers are regarded as the guardian of the nation.

Recently, Korea's semiconductor industry has turned from a surplus to a deficit with mainland China, which has led to a deficit in Korea's overall trade balance and a significant depreciation

of the Korean won, resulting in a poor economic situation. Korea's DRAM and flash memory production mainly serve consumer electronics, while Taiwan manufactures high-end applications in AI, 5G, and high-performance computing in addition to mature fields.

Taiwan's high-end processes for chips below 7nm account for more than 60% of the global market share. Since 5nm and 3nm chips are essential for AI, 5G, advanced military weapons, and missiles, whoever has 3nm and 5nm chip manufacturing will be able to win in the military area in the next 20 years. Of course, Japanese materials, Dutch ASML's DUV equipment, U.S. applied materials, and Taiwan's TSMC and other companies constitute the high-end semiconductor process ecosystem, which has a pivotal position in the global semiconductor industry.

3. The impact of the Chips and Science Act and technology control on Taiwan's semiconductor industry

The following is a discussion of the Chips and Science Act and technology regulation and their possible impact on Taiwan's semiconductor industry.

3.1. Chips and Science Act

In order to prevent the rise of mainland China in high-end semiconductor processes, the U.S. passed the Chips and Science Act and the Chip 4 Alliance to contain China. The recently announced Chips and Science Act provides about US$52 billion in subsidies for semiconductor plants investing in production and research in the U.S., as well as a 4-year lease tax credit of about US$24 billion. Another $200 billion will be invested over 10 years to promote scientific research and development in order to compete with mainland China. However, the subsidised companies will not be able to invest or expand their semiconductor investments in China below 28nm for the next 10 years. To counter this, China has also proposed that semiconductor companies receiving U.S. subsidies are not allowed to invest, set up new plants or expand existing plants in China. This geopolitical tug of war forces Taiwan, Korea and U.S. manufacturers to take sides, and the possibility of sacrificing some markets in the future is very difficult to avoid.

The large US package of subsidies, investment and tax incentives, as well as additional restrictions, represents the country's ambition to develop the semiconductor industry and its determination to use technology warfare to suppress the rise of China's semiconductor industry. The impact of this chip bill is far-reaching and the future impact on the global semiconductor industry is analysed as follows.

First, the US is determined to localise production for its semiconductor industry. For a long time, the country has focused on investments in IC design, semiconductor-related equipment and intellectual property with higher profit margins, and outsourced semiconductor

manufacturing, packaging and testing with lower profit margins. However, the impact of COVID-19 and geopolitical influences such as the U.S.-China technology war and the Russia-Ukraine war have resulted in broken chips and affected the operation of high-tech, defence weapons and missiles. Therefore, it is necessary to subsidise domestic and foreign manufacturers to manufacture semiconductors in the U.S. to reduce the their geopolitical impact and strengthen the national security of chips and technology. Intel and TSMC are investing in Arizona, Samsung in Texas; Micron will invest $40 billion to produce advanced memory chips in the U.S.; Taiwan's Globalwafers will set up a 12-inch silicon wafer fab in Texas; and Qualcomm and Grosvenor will expand production and invest in semiconductors in New York.

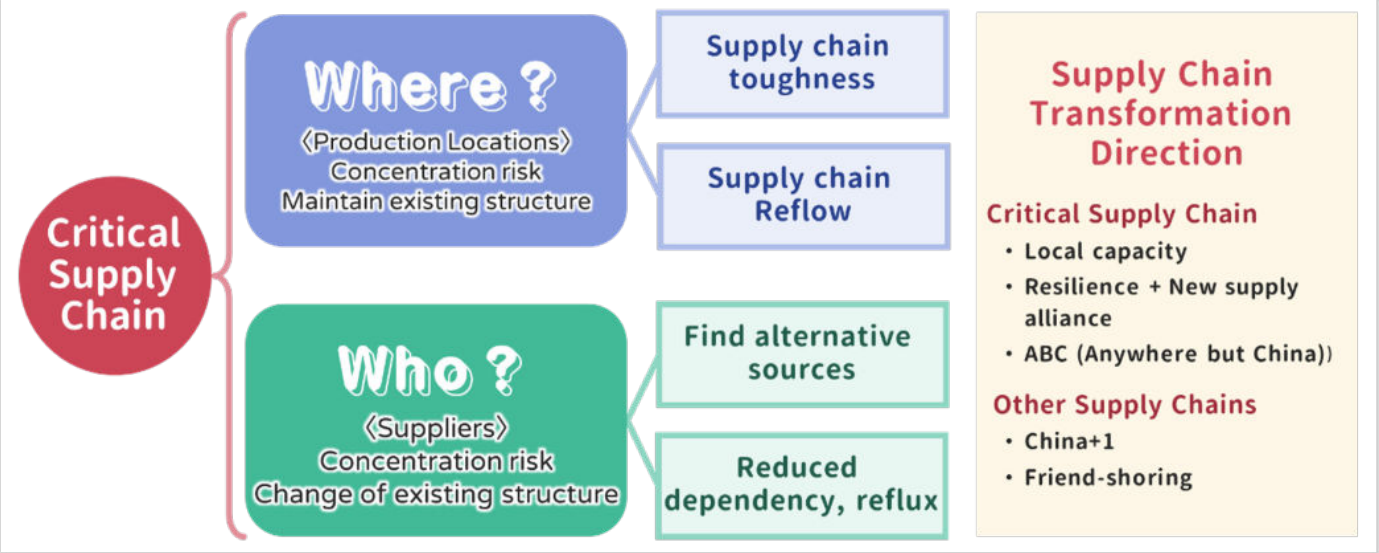
In addition to receiving subsidies and maintaining ties with the U.S. government, it is also important to serve customers in close proximity and avoid restrictions on technology and equipment from the U.S. After the U.S. encouraged these companies to invest in production, the key chips for military, aerospace, and high-tech can be produced in the U.S. without the risk of breaking the chain, thus reducing geopolitical risks.

Secondly, the Chips and Science Act will undermine the speed of China's rise in advanced semiconductor manufacturing processes. China's Semiconductor Manufacturing Corporation (SMIC) has shocked the U.S. government by claiming that it can develop 7nm chips without DUV equipment. The U.S. government's control of China's semiconductor industry, including the export of advanced technologies and equipment, will become more stringent in light of the need to maintain its core competitiveness in technology. The U.S. government will expand its control of China's semiconductor equipment exports from the current 10nm to 14nm. The technology control will also be revised downward from 7nm to 14nm to effectively suppress China's semiconductor industry.

In addition, the Chip 4 alliance is currently being formed by the U.S., Japan, Taiwan, and Korea. Once the alliance is formed, we can imagine that in the future, advanced semiconductor processes, equipment, software, key components, consumables, etc. will be controlled and not allowed to be exported to China. This will effectively widen the gap between the competitiveness of the U.S. and Chinese semiconductors. In the future, the U.S. policy will require allied manufacturers to de-centralize their advanced processes and decentralize their mature processes, and this development trend may become the new normal.

Third, the classification of supply chain restructuring and countermeasures. According to the analysis of Chun Li (2022), in addition to strengthening supply chain resilience and repatriation of semiconductors, the ICT industry and advanced batteries also require companies to find alternative sources, reduce dependence on China, and induce repatriation of vendors, all of which deserve the attention of domestic manufacturers (see Figure 1).

Figure 1. Supply Chain Restructuring: Classification and Countermeasures



Source: Lee, Roy Chun, Center for WTO & RTA, Chung-Hua Institution for Economic Research (2022).

Under the influence of the U.S. Chips Act, the semiconductor landscape of various countries will be affected. Semiconductor production is a key industry for Taiwan, and TSMC is regarded as the protector of the nation. Therefore, the government should have a policy and bottom line to prevent further U.S. or Chinese threats. At the same time, it is necessary to actively develop strategies and responses through the collective wisdom of research institutions and manufacturers.

3.2. Connotation and impact of technology control

According to the latest technology control order announced by the U.S. government, the U.S. has expanded its semiconductor suppression on China from the point (limited to specific companies) to the surface (including technology, equipment, technology applications, and talents), with the aim of controlling the export of technology and equipment and the export of personnel to start a comprehensive siege on Chinese semiconductors. Please refer to Table 1 for the details of the U.S. technology control, and Table 2 for the impact of this strict technology control on the global semiconductor ecosystem.

Table 1: Latest U.S. Technology Controls on China Semiconductors

Control Direction	Content
(1) Prohibit the outflow of technology/equipment	The export of logic chips made of less than 16 nanometres and memory of less than 18 nanometres, flash memory of more than 128 layers and related technology to China must be licensed.
(2) Prohibit the application of supercomputer technology in China	Supercomputers (machines capable of 10 gigabits per second of floating point computation in 41,600 cubic feet) and applications that acquire computing power in excess of 4,800 megabits per second are subject to control.
(3) Control of talent export	Restrictions on U.S. nationals or persons with permanent residency (green cards): (A) may not support the development or production of chips at semiconductor fabs in China; and (B) Chinese returnees working at semiconductor fabs in China must choose between renouncing their U.S. citizenship or leaving their jobs.

Source: Chris Miller, Chip War: The Fight for the World's Most Critical Technology (Simon and Schuster, 2022).

Table 2: Impact of technology regulation on Taiwan's semiconductor industry

Impacts	
1. Impact on equipment, packaging, and design companies	(1) Equipment: Fiti, Marketech (5-8% of revenue) (2) IC design: Alchip, Global Unichip, etc. (at least 30%) (3) Packaging/carrier board: ASE, UNIMICRON (<5%)
2. Impact on foundry operators	(1) Advanced process: TSMC (>5%) (2) Mature process: UMC, LMC, VIS (short-term impact is limited, but in the long term, China's focus on mature process will have a crowding-out effect)
3. Impact on TSMC	(1) China's revenue will be affected (currently 10%; direct impact) (2) AMD, NVIDIA, etc. will see a drop in revenue in China, which will affect TSMC's OEMs.
4. Impact on Taiwan's overall economy	(1) Semiconductor manufacturing, exports, and trade surplus have a huge impact on Taiwan, and any changes and shocks will have an impact (2) The semiconductor boom is declining, and the chip bill and technology control will add to the problem. (3) Taiwan has once again become a geopolitical centre (cross-strait tensions), and countries and major manufacturers are demanding to diversify their risks and go overseas to set up factories and production. (4) China's semiconductor competition in mature process (5) Impact on Taiwan's exports and trade surplus, which will affect Taiwan's economy, the stability of the NT dollar and foreign investment (FDI), and even lead to the withdrawal of foreign investment in Taiwan.

4. De-China policy will become a long-term goal of the U.S.-China technology war

The U.S. Chips and Science Act and subsequent technology controls are actually aimed at requiring major semiconductor manufacturers to choose sides, thereby delaying the gradual catch-up of Chinese mainland semiconductors and enabling the U.S. to maintain its leading edge in military weapons, AI, and 5G. However, the reality is more complex and leaves Taiwan further trapped. China is an important market for Taiwan's semiconductors, while raw materials come from Japan, equipment from the Netherlands, the US, and Japan, and intellectual property rights are in the hands of the US. It is becoming increasingly difficult for Taiwan to meet the needs of both sides, and Korean semiconductor manufacturers are also facing this awkward situation. The U.S. long-arm jurisdiction has been expanded from single-vendor control in the past to include the requirement to apply for permission to export technology below 16nm to China, while those with U.S. green cards are not allowed to take senior positions in Chinese semiconductor companies. The U.S. has also proposed slogans like ABC (anywhere but China), China+1, and China+N, which means that alternative production must be sought outside of China.

5. Taiwan's Responding Strategy

5.1. The need for TSMC to invest in Europe, U.S. and Japan

TSMC's investment in the U.S. is not only to enjoy U.S. subsidies, and tax incentives, and to avoid U.S. anti-dumping duties, but also to be close to its major customers (U.S. IC design houses) to spread the geopolitical risks and to solve the pressure of Taiwan's five shortages (shortage of water, electricity, land, labour, and talent). Taiwan's semiconductor companies, especially TSMC, will play the role of a good citizen of the world's semiconductor industry and will supply as many chips as possible for various industries, especially for the development of automotive electronics, AI, and 5G.

5.2. Operation of the Indo-Pacific Economic Framework for prosperity (IPEF)

Due to political considerations, Taiwan cannot join the Indo-Pacific Economic Framework for Prosperity (IPEF) – a new cooperation agreement between 14 Indo-Pacific nations led by the United States[1]. However, Taiwan is using the Taiwan-US 21st Century Trade Fair Initiative to promote bilateral trade agreements between Taiwan and the US and to seek opportunities to join the IPEF. With Taiwan's strength and supply chain integrity in the semiconductor and electronic information industries, it is believed that joining the IPEF will bring great contributions to the related supply chain.

1 Aidan Arasasingham et al., "Assessing IPEF's New Supply Chains Agreement," Center for Strategic and International Studies, May 31, 2023, https://www.csis.org/analysis/assessing-ipefs-new-supply-chains-agreement.

5.3. Enhancing technology depth and spread over effect

By using the bargaining chip of semiconductors, we can attract Japanese material manufacturers, European and US equipment manufacturers to invest in Taiwan, and further extend Taiwan's semiconductor industry chain to avoid a broken chain. In addition, the diffusion effect of semiconductor technology to traditional industries is also worth promoting. For example, semiconductor chips are used in agriculture for drone fertilization, in medical materials for the Da Vinci arm, and in manufacturing for smart manufacturing. Service industries for logistics, warehousing, sensing, and marketing also need the support of semiconductor chips or computing power. Therefore, the subsidies and tax incentives provided by the Science and Technology Project can strengthen the linkage and expansion of semiconductors to other fields, which will help to enhance the overall competitiveness of the industry and avoid the phenomenon of polarized industries.

5.4. Major fund to help development and layout

The establishment of a semiconductor fund can assist in the continuous development of semiconductors and the layout of investment in 3rd and 4th generation semiconductors. Through sovereign or sovereign-like funds, we can expand Taiwan's infrastructure and R&D facilities to make Taiwan's semiconductor industry more robust. At the same time, through the fund, the semiconductor technology will be extended to other traditional industries and service industries, leading to a comprehensive upgrading and transformation of the industry.

6. Suggestions for European Countries

Due to the US-China trade war, the restructuring of global supply chain is in urgent need. Consequently, if central and eastern European countries could provide some incentives and better infrastructure as soon as possible, it can encourage more companies (especially Taiwanese companies) moving out from China to invest in east and central Europe.

Moreover, semiconductor investment is dependent on national resource leverage effects. In addition to the European Chips Act, if individual countries could provide better incentives, infrastructure support and other more aggressive industrial policies, this will help IC companies from Taiwan and Korea to choose to invest with top priority in Europe.

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